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FROM THE DESK OF THE CHAIRMAN



Dr. S. Christopher

SECRETARY Department of Defence Research and Development

CHAIRMAN Defence Research and Development Organisation (DRDO)

he country is passing through a difficult phase. Internally, we are fighting against the corruption and black money and externally with the insurgency at the border and LoC. In the recent past, we saw Uri, Sambha and Nagrota attacks, where our brave soldiers made supreme sacrifice. At the outset, DRDO fraternity vows solidarity with the security forces and salutes our fallen heroes for laying down their lives in securing our borders to make us safe and secure. DRDO community joins the nation to express extreme anguish and grief and offer condolences to their bereaved families.

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Recently, I had a chance to interact and share my thoughts with the young, confident and motivated scientists from DRDO labs in the "Young Scientists Meet (YSM)" conducted at Delhi. It is true that every effort cannot be translated into success and it is also true that success doesn't come without efforts. We have to remain motivated, which is not easy, but neither impossible. The motivation comes from our goals, our dreams and with the sense of accomplishments and achievements. We need to work as a determined team and put our best foot forward in the service of this great nation. How do we do it? What are our options for creating a niche in the minds of our valiant soldiers? What should be our short, medium and long term goals and whether they are in sync with advancing technology? What could be the possible themes for DRDO in years to come? Let's explore them together. I would appreciate receiving your ideas at "s.christopher@hqr.hqrdom".

In my last editorial, I had urged to move towards digitisation, save energy, grow trees and work towards a cleaner and healthier environment. DRDO is contributing in the "Digital India Initiative." We have introduced text/SMS service to track foreign deputation cases, clearances for the foreign visitor request and e-tendering etc. With the government's initiative of demonetisation and moving towards the cashless economy, I expect a whole hearted support from DRDO. DRDO community may reach out to the society to make them also understand its benefits in the long run in making a better future for all of us. I am also thinking to introduce card transactions in DRDO guest houses. These small steps would prove a quantum leap forward towards building India a great country.

Jai Hind



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RUSTOM-II Successfully Completes Maiden Flight

eralding a new era in the indigenous development of Unmanned Aerial Vehicle (UAV), DRDO successfully carried out the maiden flight of TAPAS 201 (Rustom-II), a Medium Altitude Long Endurance (MALE) UAV on 15 November 2016. The test flight took place from Aeronautical Test Range (ATR), Chitradurga—a newly developed flight test range for the testing of UAVs and manned aircraft-250 km from Bengaluru. The flight accomplished the main objectives of proving the flying platform, such as take-off, bank, level flight and landing etc.

TAPAS 201, has been designed and developed DRDO's Aeronautical Development Establishment (ADE), Bengaluru, with HAL-BEL as the production partners. The UAV weighing two tonnes was put into air by a dedicated team of young scientists of DRDO and was piloted (external and internal) by the Armed Forces. It is also the first R&D prototype UAV that has undergone certification and qualification for the first flight from the Centre for Military Airworthiness and Certification (CEMILAC) and Directorate General of Aeronautical Quality Assurance (DGAQA).

The multi-mission UAV is being developed to carry out the Intelligence, Surveillance and Reconnaissance (ISR) roles for the three Armed Forces with an endurance of 24 hours. It is capable to carry different combinations of payloads like Medium Range Electro Optic (MREO), Long Range Electro Optic (LREO), Synthetic Aperture Radar (SAR), Electronic Intelligence (ELINT), Communication Intelligence (COMINT) and Situational Awareness Payloads (SAP) to perform missions during day and night.

The development of Rustom-II immensely contributes towards the Make-in-India initiative as many critical systems such as airframe, landing gear, flight control and avionics sub-systems are being developed in India with the collaboration of private industries. Defence Electronics Application Laboratory (DEAL), Dehradun, has developed the data link for the UAV. Rustom-II will undergo further trials for validating the design parameters, before going for User Validation Trials.





Navy Inducts Indigenous Sonars



Raksha Mantri Shri Manohar Parrikar handed over four types of indigenously sonars developed by DRDO to Admiral Sunil Lanba, Chief of the Naval Staff on 18 November 2016. Dr S Christopher, Secretary, Department of Defence R&D and Chairman DRDO, was present on the occasion. The systems have been designed and developed by NPOL, a Kochi-based DRDO laboratory.

The indigenous systems, which included Abhay—compact hull mounted sonar for shallow water crafts, Humsa UG—upgrade for the Humsa sonar system, NACS—Near-field Acoustic Characterisation System, and AIDSS— Advanced Indigenous Distress Sonar System for submarines, will boost the underwater surveillance capability of the Navy.

Abhay is an advanced activecum-passive integrated sonar system designed and developed for the smaller platforms such as shallow watercrafts and coastal surveillance/patrol vessels. It is capable of detecting, localizing, classifying and tracking sub-surface and surface targets in both its active and passive modes of operation. The prototype of this compact sonar installed onboard a nominated naval platform has successfully completed all user evaluation trials to demonstrate the features as per the Naval Staff Qualification Requirements. Indian Navy has proposed to induct this SONAR on three of the Abhay class ships.

Intensifying the command over the high seas is the HUMSA-UG that is designed for upgrading the existing HUMSA SONAR system of the Indian Naval platforms. The hardware architecture is based on the state-ofthe-art open architecture processor technologies that will enable smooth upgrade of the system capabilities.

NACS determines the in situ performance of the SONAR systems, which are used to find the frequencydependent 3-D transmission and reception characteristics of the SONAR. It is also used to measure the magnitude



and phase characteristics of the SONAR transmission and reception electronics and the transducers. The NACS has been integrated with the HUMSA-NG SONAR array and proved onboard Naval platforms and this will be fitted on all frontline ships.

NPOL has also developed AIDSS, a distress SONAR that is an Emergency Sound Signalling Device, which is

used to indicate that a submarine is in distress and enable quick rescue and salvage. It is a life-saving alarm system designed to transmit SONAR signals of a pre-designated frequency and pulse shape in an emergency situation from a submarine for long period, so as to attract the attention of Passive SONARS of Ships or Submarines in the vicinity and all types of standard rescue vessels in operation. It is also provided with a transponder capability. With the induction of these four systems, the underwater surveillance capability of the Indian Navy will get a boost, besides providing a fillip to the quest for self-reliance in this critical area of technology.

DRDO signs MoU with IIT Delhi to Establish JATC

efence Research and Development Organisation signed a Memorandum of Understanding (MoU) with Indian Institute of Technology (IIT), Delhi, to establish a 'Joint Advanced Technology Centre (JATC)' at a function held in IIT, Delhi on 4 November 2016. JATC will be located in the campus of IIT Delhi at the upcoming Science and Technology Park (Mini Science Park).

Secretary, Department of Defence R&D and Chairman DRDO Dr S Christopher, signed the MoU with the Director IIT Delhi Prof. V Ramgopal Rao. The JATC will enable Directed, Basic and Applied Research and will engage with premier research institutes through multi-institutional collaboration.

As per the MoU, DRDO will support JATC in equipping it with advanced and unique research facilities that will enable the faculty and scholars to conduct advanced research and transform the JATC as Centre of Excellence. DRDO scientists and engineers will work with the academic research faculty and scholars in addressing scientific problems to find an innovative solution. DRDO will facilitate towards advanced research to utilize technology outcome



in the futuristic applications.

The objective for creation of JATC is to undertake and facilitate multidisciplinary directed basic and applied research in the jointly identified research verticals. The researchers will get the opportunity to work in advanced areas of research namely Advanced Materials for Ballistic Protection. Advanced Mathematical Modelling and Simulation, Advanced Electromagnetic Devices and Terahertz Technologies, Smart and Intelligent Textile Technologies, Brain Computer Interface and Brain Machine Intelligence besides Photonic Technologies, Plasmonics and Quantum Photonics, etc. The focused research efforts at the Centre will lead to realization of indigenous technologies in these critical areas, which will be used for speedy self-reliance.

Faculties and researchers in various Engineering and Science departments of IIT Delhi will participate in the research programme/projects of the Centre. JATC may also involve other premier institutions in the region, based on their research strengths. DRDO-MILITARY INTERFACE DRDO NEWSLETTER



DRDO hosts 58th Conference of International Military Testing Association



efence Institute of Psychological Research (DIPR), a Delhi-based DRDO laboratory hosted the 58th Conference of International Military Testing Association (IMTA) in New Delhi during 7-11 November 2016. The four-daylong conference was held for the first time in India and was inaugurated by the Minister of State for Defence Dr Subhash Bhamre. Secretary, Department of Defence R&D and Chairman DRDO Dr S Christopher and Ms Susan Truscott, Chair of the IMTA and Director General Military Personnel Research and Analysis, Canada, also attended the conference.

Dr Subhash Bhamre, in his inaugural address, expressed the need to take adequate steps to counter stressrelated manifestations in soldiers. He said with rapid pace in technological advancement and information warfare gaining in strength day-by-day, these factors are taking a heavy toll on the human element. Insurgencies, terrorism and fundamentalism are the threats that an Indian soldier faces within the country and handling adversaries from within is a big hurdle. he further added. He opined that to select, train and sustain the military in such a hostile environment needs good selection, training and nurturance and an event such as this conference would provide an excellent platform for all delegates to share the unique challenges that soldiers face in their respective countries and the novel methods based on scientific principles that have been evolved to mitigate those problems.

Appreciating the theme of the conference, the Minister said that the shaping could take place by optimizing the soldier's performance. He called upon the delegates that their vision statement should be "Soldier preparedness and well-being of the soldier" for mental and physical wellbeing of the soldier.

Complimenting the DIPR, Dr Bhamre said the assessment system, methodologies, techniques and tests developed by the Institute are being used by 20 Services Selection Boards spread over the country. He further stated that it is a matter of pride that India's Armed Forces, which are the world's third largest are scrutinized through tests developed by DIPR.

Over 127 delegates from 21 countries including host India participated in the conference. Dr S Christopher and Ms Susan Truscott also spoke on the occasion.

DRDO-MILITARY INTERFACE

Special Training Program in Psychological Counselling for Army Officers

efence Institute of Psychological Research (DIPR), Delhi, conducted a special training program in Psychological Counselling for the Army Officers. The program was conducted during 19 September 2016 to 7 October 2016.

The training program is being conducted on the directives of Hon'ble Raksha Mantri and was inaugurated by Dr Shashi Bala Singh, Outstanding Scientist and Director, Defence Institute of Physiology and Allied Sciences (DIPAS), Delhi.

Forty-eight Indian Army officers in the ranks from Captain to Lieutenant Colonel attended the program. Around 20 expert speakers, specialized in the area, from various institutions, academia and hospitals shared their knowledge and expertise with the participants by means of delivering enlightening talks and conducting practical sessions. Dr Updesh Kumar, Scientist 'G' and Head, Mental Health Division was the Program Director and Dr Archana, Scientist 'E' was the coordinator.

The program was 10th in the series and so far more than 350 officers have been trained in psychological counselling who are delivering their services at the units and formation levels of Indian Army.

Dr K Ramachandran, Director, DIPR, delivered the Valedictory address.



DRDO-MILITARY INTERFACE DRDO NEWSLETTER



Training on Camouflage for E-CAM-46 Course



raining program on Camouflage for E-CAM-46 course for Service Officers was organised during 3-7 October 2016 at Defence Laboratory Jodhpur (DLJ). Dr SR Vadera, Outstanding Scientist and Director, DLJ, inaugurated the program.

Sixteen Service Officers from Army, Navy and Air Force attended the training. The training program comprised 11 theory lectures covering various aspects of camouflage and practical training on Sigma Mk II. Field visits to Data Processing Centre (DPC), CHAFF Production Facility, Mock-ups Workshop and Near Field Diagnostic Radar cross-section measurement Facility (NFDRF) at Air Force Station Jodhpur, were arranged during the course. A performance evaluation test was conducted for the course participants after completion of all theory and practical classes. An Open House was organised at the end of the course to discuss various aspects related to the course including course contents, feedback of the participants and other issues related to camouflage.

Shri NK Agarwal, Scientist 'G' was the Course Director and Shri RK Khatri, Scientist 'E' was the Coordinator for the course.



Asian Ministerial Conference on Disaster Risk Reduction



Ational Institute of Disaster Management (NIDM), Ministry of Home Affairs, Govt of India, organized an exposition as part of the Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR), held during 2-5 November 2016, at Vigyan Bhawan,

New Delhi. The event was inaugurated by hon'ble Prime Minister of India Shri Narendra Modi, and has participants from over 30 countries.

DRDO also participated in the event and showcased disaster management technologies/products indigenously developed by the organsiation. Nineteen DRDO labs/estts showcased their products and technologies in the exhibition.

Institute of Nuclear Medicine and Allied Science (INMAS), Delhi, was the nodal laboratory for organizing the exhibition at the event.



Courses

Workshop on Neuroimaging in Cognitive Research

Institute of Nuclear Medicine and Allied Sciences (INMAS), Delhi, organised a workshop on "Neuroimaging in Cognitive Research" during 14-15 October 2016 to discuss technological developments and advances in the field of Neuroimaging and how it can be applied to cognitive research. The objective of the workshop was to synergise the research endeavours of INMAS with other DRDO life sciences laboratories and potential collaborating academic institutes. Main focus of workshop was towards understanding state-of-the-art neuroimaging techniques and their clinical/ preclinical as well as military applications. More than 50 participants from establishment pursuing research in this field participated in the workshop.



Workshop on Radar Stealth Material Technologies

A workshop on "Radar Stealth Material Technologies" was organized at Defence Laboratory Jodhpur during 21-22 October 2016 to synergies the efforts for meeting the Radar Stealth Material requirements of Services, DRDO, and ADA. Dr SC Sati, DG (NS&M), DRDO, inaugurated the workshop. Thirty-six scientists/officers working in the relevant areas of radar stealth for airborne and naval applications participated in the workshop. Significance of the work to the user and project proposals for collaboration were deliberated in detail during the deliberations.



All India Rajbhasha Scientific Seminar 2016

Naval Physical and Oceanographic Laboratory (NPOL), Kochi, organized All India Rajbhasha Scientific Seminar on 21 October 2016 on "Patenting in Defence R&D" and "Made in India for Economic Growth." Sixteen delegates presented papers in the seminar. Proceedings of the seminar and "Pavan"—NPOL's Rajbhasha Bulletin—were also released on the occasion.



CEP on EMI-EMC for Avionics

Research Centre Imarat (RCI), Hyderabad, conducted a CEP course on "EMI-EMC for Avionics" during 7-11 November 2016. The course was aimed at introducing Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) awareness and imparting EMC design knowledge for the development of avionics and electronic systems. Shri BHVS Narayana Murthy, Outstanding Scientist and Director, RCI. Fifty-two participants from eight DRDO labs attended the course.



Hindi Workshop

RCI, Hyderabad, organised 2nd Hindi Workshop on 8 November 2016. Shri T Narasimha Rao, Sc G, and Vice Chairman OLIC inaugurated the workshop. Shri MK Gupta, Sc E, Member Secretary OLIC, gave overview of Hindi activities of RCI. Dr Rajnarayana Awasthi, Hindi Officer, ECIL Hyderabad, delivered lecture on Noting and Drafting. Shri Kazim Ahmed, Senior translator, RCI, delivered a lecture on Hindi Grammar.



CEP on Development of Mission Critical Applications

NPOL, Kochi, conducted a course on "Development of Mission Critical Applications: Technologies and Best Practices" under Continuing Education Programme (CEP) of the DRDO during 2-4 November 2016. The course was aimed to update the knowledge of the participants on technologies and best practices in the domain of Mission Critical Applications.



DRDO participates in MET & HT Show

NMRL organized the Exhibition and Conference on Materials Engineering Technology (MET) and Heat Treatment Show (HTS) conducted by ASM, International India chapter in Navi Mumbai from 12-14 October 2016. Shri Manohar Parrikar, Hon'ble Minister of Defence, Govt. of India inaugurated the event. Dr RA Mashalkar, former DG CSIR, accompanied Hon'ble Raksha Mantri. The event provided an opportunity for interaction with industries, students and academicians.

DIBER celebrates 56th Raising Day

Defence Institute of Bio-Energy Research (DIBER), Haldwani, celebrated its 56th Raising Day with grandeur on 21 October 2016. Dr S Christopher, Chairman DRDO and Secretary Department of Defence R&D was the chief guest for the event. A slide show on "DIBER: From Snow to Sea, a Journey of 55 years", which highlighted the success stories and the impact made by DIBER was screened on this occasion. A Coffee Table Book on DIBER was also released by the Secretary.







Personnel News

Dr (Mrs) Shashi Bala Singh takes over as DG Life Sciences DRDO

Dr (Mrs) Shashi Bala Singh, Outstanding Scientist, Director, DIPAS, Delhi, has been appointed Director General (Life Sciences), DRDO, wef 1 November 2016. She has the distinction of serving in the immensely difficult terrain of Leh, Ladakh as Director, Defence Institute of High Altitude Research (DIHAR), Leh, and



has pioneered research on permafrost-based germplasm conservation, climate change mitigation and development of herbal interventions for improving performance at high altitude.

Dr KM Rajan, Director, ARDE, promoted to Distinguished Scientist

Dr KM Rajan, OS and Director, Armament Research & Development Establishment (ARDE), Pune, has been promoted to the grade of Distinguished Scientist wef 27 October 2016. A Mechanical Engineer with a PhD in the area of Flow Forming from IIT Bombay, Dr Rajan has an MBA and a German language certification.



Higher Qualification Acquired

Shri M Manickavasagam, Sc 'G' and Project Director A1P, Advanced Systems Laboratory, Hyderabad, has been conferred PhD in computing from Sastra University, Thanjavur, for the thesis entitled 'Trajectory Optimization of Flight Vehicles for Offline and Real-Time Applications.



Smt Meena D, Sc 'F', Electronics and Radar development Establishment (LRDE), Bengaluru, has been awarded PhD by Indian Institute of Science Bangalore (IISc), Bangalore for the thesis titled 'Optical WDM systems for Multipoint Distribution of hybrid signals in Phased array radar Applications'.

Shri Vikas Kumar Dewangan, Sc 'E' Electronics and Radar development Establishment (LRDE), Bengaluru, has been awarded PhD by IISc, Bangalore for the thesis titled 'Role of Power Control in Enhancing the Performance of Opportunistic selection schemes'."



Sports Round-up

Defence Food Research Laboratory (DFRL), Mysuru organised DRDO South Zone Table Tennis Tournament for the year 2016-2017 during 26-28 October 2016. Dr Rakesh Kumar Sharma, Director, DFRL inaugurated the tournament. Players from various DRDO laboratories/establishments of the South Zone participated and competed under various categories enthusiastically. The Winners are:

Men's Single and Double: Mr Raghavendra, and Raghunath KV and Krishna HA, from GTRE, Bangaluru

Women's Single: Mrs Suganya

Mixed Double: Dr Farhath Khanum & Mr Satish Kumar from DFRL, Mysuru

Over all Team Championship and Runners-up: GTRE, Bangaluru and DFRL, Mysuru



DRDO HARNESSING SCIENCE FOR PEACE AND SECURITY- X CHAPTER 1: THE BEGINNING - DEFENCE SCIENCE

The article is tenth in the Series of extracts of the monograph, "Defence Research & Development Organisation: 1958-1982", by Shri RP Shenoy, former Director of Electronics and Radar Development Establishment (LRDE).

THE FIRST FOUR YEARS

n this manner, Dr Kothari focused his energy and effort to build the scientific temper in his scientists. He initiated the holding of weekly seminars in the Defence Science Laboratory where individual scientists were to report on some particular topic of defence interest. In spite of the many demands on his time, he generally managed to attend these seminars and participated in the discussions. In addition, he deputed selected civilian scientists on temporary attachment to military establishments to enable the defence scientists to acquire first-hand knowledge of field conditions.

He stressed that unlike in the academic world, in defence, research is a means to an end and that the most important thing in defence research and development was the selection of problems on which the available effort could be effectively concentrated and speedily attended to. Therefore, he considered that the research and development effort should be mainly directed to the twin objectives of enabling the Armed Forces to make the best operational use of existing weapons and equipment and of continually seeking new weapons, including the undertaking of major changes in existing weapons to gain a lead over potential aggressors. The first objective, according to him, could be met by operational research and that no other field of research or development had so far provided a larger yield than this scientific activity in relation to the effort expended on it. Scientists could achieve success in this area in closer association with Service personnel as an intimate knowledge and experience in their operational use was essential.

Dr Kothari also considered that assistance to the Services to assess the operational effectiveness of different weapons would be extended so that within the available financial resources, the most effective weapons would be purchased. Apart from operations research, he desired that the Defence Science Organisation to assist the Services in other ways which he spelt out as

- (a) modification of existing weapons to suit them to local conditions, such as tropicalisation, and operation of radar in the presence of super refraction
- (b) keep abreast of the developments in advance weapons work in foreign countries
- (c) suggest improvements in inspection techniques and procedures
- (d) design and development work related to indigenous production of existing conventional weapons that were being imported
- (e) research and also design and development of new weapons of the World War II class, and
- (f) research with a view to develop radically new weapons.

The second objective, namely seeking of new weapons or carrying out major improvements to existing weapons embodied in (e) and (f) above, in his opinion, would be successful only against a background of high level scientific knowledge and industrial productivity. He opined that these tasks are not likely to be undertaken in the country for the next few years. Therefore, activities related to technology and weapon systems development were not taken up.

In early 1950's the scientists of the Defence Science Organisation moved out of the "temporary hutments near the Central Secretariat and shifted to the second floor of the National Physical Laboratory of the CSIR to form the Defence Science Laboratory (DSL). This enabled the scientists of the DSL to get the benefits of interaction with the NPL scientists and also access to the laboratory facilities of the NPL. Further, they also could use the excellent library facilities available at NPL. The DSL was fortunate to have the services of Shri Dhanpat Rai who performed pro-actively in providing the scientists the latest information on the projects they were working on and also in their areas of specialisation. He spared no efforts to build a tradition of timely and efficient information collection and service and laid the foundation for the present DESIDOC. After the move to NPL premises it was decided to set up a small workshop for which Rs 15 lakhs were sanctioned to equip it over a period of three years.

Professor Kothari identified operations research, ballistics, explosives, armaments, rockets and missiles, food and nutrition, life sciences including medicine, environmental physiology



and psychology, as the areas for the defence scientists to work upon. Of these, operations research was given more importance for reasons cited earlier. He believed in starting the activities in a modest manner and in a small way and build them up and therefore, instead of departments, he set up cells in each of these disciplines. In the period 1949-1952, over 200 weekly seminars had been held covering topics related to defence science so that the scientists belonging to different disciplines could interact and also consolidate their knowledge on the topics.

In addition, two symposia, one on internal ballistics and the second on external ballistics were organised for interaction and exchange of views between the defence scientists and the Service technical personnel. These were found very fruitful as they clarified most of the issues - operational aspects for scientists and scientific aspects for Service Officers - and led to better understanding and appreciation of each other's views. At the instance of the Defence Science Organisation, many universities, such as Delhi, Calcutta, and Saugor either introduced ballistics in their postgraduate courses which would benefit defence in terms of availability of more trained persons either for active duty or for Defence Science Laboratory for research activities.

An Institute of Armament Studies was planned and established with the main object of studying and carrying out research on the performance of weapons and equipment, for serving as a centre for Service Officers to be trained in the principles and design of different types of armaments to take up Technical Staff Officers appointments, and for maintaining contacts with civilian research institutions. In 1952, laboratories were established in Mumbai and Kochi for taking up research in problems related to the Indian Navy. These formed the nucleus for the present Naval Materials Research Laboratory in Mumbai and the Naval Physical and Oceanographic Laboratory in Kochi.

To enlarge the scientific effort on defence beyond the confines of his

fledgling organisation, and to create and promote awareness and interest of the academicians and other civilian science research and development organisations in defence science subjects, the second Defence Science Conference was organized in April 1952. The delegates and invitees were academicians from a number of universities, scientists from civilian research organisations such as the CSIR laboratories, scientists and service officers from the TDEs, experts from the armed forces, who for full six days covering over fourteen technical sessions, interacted, exchanged data, views and formed opinions as well as associations. The sessions covered internal ballistics, external ballistics, operations research, materials, rockets, electronics including radars, psychology and personnel research. However, the focus was on operations research, ballistics, psychology and personnel research.

The Defence Science Conference also marked the end of the full time involvement of Dr Kothari as Scientific Adviser to the Ministry of Defence. Dr Kothari, who had earlier given himself three years to hold the office of the Scientific Adviser was persuaded to continue for one more year. On completion of his tenure as full-time Scientific Adviser on a University Professor's emoluments, he returned to research and teaching at Delhi University. His going back to the university was not because he did not consider the work in defence important, or because he had any difficulty in the Defence Ministry, but because he considered that the post of the Scientific Adviser was a post where other scientists should come in and see for themselves how important the work is and how interesting it is. The Government of India while respecting his wishes requested him to continue as Scientific Adviser to the Defence Ministry, which he performed on a token salary of Rupee one per month. He continued to provide guidance and direction to the scientists of the Organisation and advice to the Government on scientific matters pertaining to defence on a part-time basis for nearly ten years.

The major gains made by the Defence Science Organisation in the first four years of its existence was making the Services conscious of the role scientist, a could play in the solution of defence problems. Mr HM Patel who was the Secretary Defence and Chairman of the Defence Science Advisory Board in March 1953, stated that the organisation "cannot as yet claim to have done much more than made scientists and Services alike conscious of the fact that our scientists have a definite and direct role to play in the solution of purely defence problems. To my mind it is nevertheless a big achievement and it is all the more satisfactory in that it is the result on the one hand of proving to the Services by actually resolving some of their minor but for that reason annoying difficulties, that they can be of very real help to them and on the other hand of convincing the universities and other research scientists who have been hitherto totally unfamiliar with military matters that the problems of defence were in essence no different from other scientific problems and were indeed no less challenging.

It is a matter of satisfaction that our organisation has already been able to make some contribution, however slight, to the pool of scientific knowledge on defence problems of common interest. I am confident that as our organization expands, slowly but surely, it will be able to play more adequate part in this cooperative endeavour". No rapid growth as was being experienced by the other S&T organisations in this period was visualised for the Defence Science Organisation.

PERFORMANCE BALANCE SHEET

The Defence Ministry after 1952 came under the direct charge of the Prime Minister who appointed a minister of state for looking after the day to day matters of the ministry. It is in this period that Dr D S Kothari as Scientific Adviser to the Defence Ministry came in closer touch with the Prime Minister and there is no doubt that Pandit Nehru's regard for Dr Kothari's abilities as a scientist and for his qualities as a human being also grew. Dr Kothari continued to remain part time Scientific Adviser to the Defence Ministry most presumably at the behest of the Prime Minister.

There was appreciation by the Services that, "Dr Kothari had a deep and penetrating knowledge of defence matters and there was no conference on military strategy or tactics in which he did not participate usefully. Whenever Dr Kothari was called into a meeting in the Ministry of Defence, he would speak out plainly and was listened to respectfully and his views were accepted...". In 1952, he was able to convince the Army the usefulness of analysis in weapons evaluation and this resulted in the Directorate of Weapons and Equipment in the General Staff Branch of the Army, forming an 'Operational Research Unit' which was manned by scientists and soldiers together.

Over a period of about eight years, the defence scientists in areas of operations research, ballistics, weapons evaluation, physiological and psychological readiness, and food and nutrition honed their skills and were able to assist the Services. A brief account of some of the work carried out would be in order.

Operations Research

The studies and investigations were, introduction of scientific techniques for evaluation of new weapon systems, analysis of the impact of new weapons on tactics and strategy, and operational research studies to improve fire power.

Explosives

The focus was on the terminal ballistics and relating the chemical composition to the power of the explosive. The first set of studies covered the analysis of penetration of hollow charges against armour plates by the theory of pressure ionisation in condensed matter. This led to a better understanding of the phenomenon of armour penetration and made the indigenous design of antitank ammunition with modern powerful explosives, such as RDX and HMX, possible. An apparatus for measuring blast pressures was developed and investigations were carried out about the processes involved in the manufacture of RDX. Another area of investigation were on fragmentation of bombs and shells on explosion. Here, analytical studies led to the important conclusion that the same statistical theory is valid for both random fragmentation in star formation and for mass distribution of shrapnel from an exploding shell. Relationship between chemical composition and velocity of detonation of explosive compounds was studied for assessing their power and brisance. Investigation of the mechanics of explosive behaviour was carried out for specific chemical compounds and their sensitivity towards heat and impact were quantitatively established.

Military Physiology

The studies centred on the physiological problems of the Indian soldier in the tropical heat-dry heat conditions as in Rajasthan and wetheat conditions as in Assam. Initial studies were carried out in controlled environment of the laboratory with respect to salt and water requirements with a view to check salt deficiency and drawing a regime of water intake. Another study focused on caloric requirements of the soldier by relating energy expenditure to actual consumption of food during collective training periods. Another set of studies referred to the load carried out by infantry soldiers in relation to different climatic and terrain conditions. The focus here was to establish a relationship between stride length, frequency of stepping and speed in normal walk and the impact of muscular fatigue so that the effect of load on the speed of marching and optimum load distribution could be determined.

Applied Psychology

The evolving of a reliable assessment method for selection to the Services was one of the investigations carried out by the Psychological Research Wing. The revised rating scale consisting of fifteen qualities based on four factors was developed and was adopted by the Services for use. Another area of study was about the human factor in man-machine systems, such as the fighter aircraft for efficient operation, flying safety and instrument design.

Electronics

The studies that were conducted were aimed to understand the effect of super refraction leading to anomalous propagation on the performance of radars. The anomalous propagation occurred in tropical countries in the summer and monsoon months and their study was essential to site future systems in these areas as well as to determine the coverage gaps that might occur, the time of occurrence and duration of the phenomena. The studies on obstacle diffraction and gain were aimed at the propagation aspects of radio waves in mountainous region which is the characteristic of the terrain on our northern borders, especially for location of transmitters, repeaters and receivers.

Food & Nutrition

One area of study dealt with the factors to be considered for formulating Service rations in tropical climates. In particular, the nutritive value of oil dehydrogenised serum cholesterol and phospholipid levels of service personnel was investigated prior to developing pre-cooked dehydrated foods for the soldiers. A new ten-man pack ration was developed and the techniques for production of quick cooking and easily digestible foods were evolved.

Applied Chemistry

The naval laboratory at Bombay undertook important studies on Fouling so that the formulation of specifications for antifouling paints could be generated for taking up indigenous manufacture.

Biological Effects of Radiation

These studies were initiated in 1956 for alleviation of human suffering and study of physical disorders like thyroid deficiency through nuclear medicine such as radio iodine.

To be continued...





Important Visits

Honourable Raksha Rajya Mantri (RRM), Dr Subhash Bhamre visited **Naval Physical Oceanographic Laboratory** (NPOL), Kochi, on 12 November 2016. Dr Subhash Bhamre interacted with the scientists and appreciated the technologies and products developed by NPOL. Shri S Kedarnath Shenoy, OS and Director, NPOL, welcomed the Minister and briefed him about the achievements and ongoing projects at NPOL. The Minister described NPOL as the best performing laboratories in DRDO and lauded its role

in developing systems and technologies for the enhancement of the Indian Navy's operational capabilities. Contributions of DRDO and NPOL towards indigenisation would contribute towards the realisation of Prime Minister's 'Make in India' initiative a success, said the RRM.



Lt Gen JS Cheema, VSM, DG Infantry along with Brig. Rajwant Singh, DDG Infantry (B), visited **Armament Research and Development Establishment** (ARDE), Pune, on 14 October 2016. Presentations on the projects related to Small Arms and Low Intensity Conflict weapons were given to the visitors during the visit.



International Business Times

Rs 80,000 crore defence deals: LCAs, T-90 tanks, UAVs and Pinaka missiles to boost armed forces.

The procurements will also be a boost to Prime Minister Narendra Modi's flagship Make in India initiative.



efence Minister Manohar Parrikar has, in a meeting of the Defence Acquisition Council (DAC) which he chaired, cleared defence deals worth Rs 80,000 crore, and also given his nod to a new blacklisting policy that replaces the one where any firm found indulging in corrupt practises would be permanently barred from competing for defence contracts.

The deals finalised are for the procurement of light combat aircraft (LCAs), T-90 tanks, unmanned aerial vehicles (UAVs) and Pinaka missiles, all manufactured in India. The procurement of the LCAs is in line with the policy the government had outlined earlier Besides strengthening the armed forces further, the procurements will also be a boost to Prime Minister Narendra Modi's flagship Make in India initiative, which looks to boost manufacturing and industry in India. Also, limiting defence procurement to Indian firms would also reduce the chances of leaking of data, as happened in the case of the high-tech Scorpene submarines.

Details of procurement

One of the primary acquisitions will be an improved version of the Tejas LCA, up from Mark 1 to Mark 1A or Mark 2. The Indian Air Force (IAF) will get 83 of them from Hindustan Aeronautics Ltd (HAL), in a deal valued at Rs 52,000 crore. Several other Tejas aircraft have already been tested by the IAF, and are expected to be inducted into it by next year or the year after that.

Another deal the DAC cleared is for 15 light combat helicopters, to be used by both the Indian Army and the IAF. These, too, will be produced by HAL. The armed forces will also get around 600 UAVs from Indian manufacturers. Many of these UAVs are expected to be used to help the country seal its border with Pakistan, deterring infiltrators and terrorists.

The DAC has now ordered the procurement of 464 T-90 tanks from Russia. This is also expected to deepen India's military ties with Russia.



Times of India

Def Aerospace R&D Centre: Work to begin at IIT-Bombay

ummary: "PhD students will take over the project for DRDO to do research and build aeronauticalrelated equipment. "The official said at IIT-M, this centre has 45 faculty across eight departments participating in the project, while at IIT-B, 25 faculty across departments will participate in the research being conducted for the first time in India. IIT-B will be the administrative headquarters for the new CoPT. Mumbai: The foundation stone for construction of the advanced defence-related aerospace research and development centre (Centre of Propulsion Technology) will be laid on IIT-Bombay premises on Friday, in the presence of defence minister Manohar Parrikar, Defence Research and Development Organization (DRDO) director, and IIT-B and IIT-Madras directors.The MoU was signed last year after DRDO decided to finance over Rs 400 crore into IIT-B and IIT-M to kick-start advanced defence-related aerospace research and development. A defence official said products and technology under development include aircraft that can morph into a missile, gas turbine engines used to run aircraft and missile propulsion and hypersonics that enable flights to go at several times the speed of sound.

Mumbai: The foundation stone for construction of the advanced defence-related aerospace research and development centre (Centre of Propulsion Technology) will be laid on IIT-Bombay premises on Friday, in the presence of defence minister Manohar Parrikar, Defence Research and Development Organization (DRDO) director, and IIT-B and IIT-Madras directors.



New Delhi, November 10, (Scoop News Bureau)-The Minister of State for Defence Dr. Subhash Bhamre has said that stress-related manifestations in soldiers are on the rise and has expressed the need to take adequate steps to counter them. He said with rapid pace in technological advancement and information warfare gaining in strength day-by-day, these factors are taking a heavy toll on the human element.

Dr. Bhamre was inaugurating the 58th Conference of International Military Testing Association (IMTA) organised by Defence Institute of Psychological Research (DIPR), a Delhi based laboratory of DRDO, here on Tuesday.

Dr. Bhamre stated that insurgencies, terrorism and fundamentalism are the threats that an Indian soldier faces within the country and handling adversaries from within are a big hurdle. He opined that to select, train and sustain the military in such a hostile environment needs good selection, training and nurturance.

The Minister said that an event such as this conference would provide an excellent platform for all delegates



to share the unique challenges that soldiers face in their respective countries and the novel methods based on scientific principles that have been evolved to mitigate those problems. Appreciating the theme of the 4-day conference 'Psychological Assessment: Shaping the future Soldier' the Minister said that the shaping could take place by optimizing the soldier's performance. He called upon the delegates that their vision statement should be "Soldier preparedness and well-being of the soldier" for mental and physical well-being of the soldier.

Dr. S Christopher and Chair of the IMTA and Director General Military Personnel Research and Analysis (DGMPRA) of the Canadian Department of National Defence, Ms Susan Truscott also spoke on the occasion.

